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September 4, 2015

Ms. Michele Dermer
EPA Region 9, WTR-9
75 Hawthorne St.
San Francisco, CA 94105

**Subject: Response to Comments in EPA Letter Dated August 27, 2015
PG&E Test Injection/Withdrawal Well 1
Permit No. R9UIC-CA5-FY13-1
King Island, San Joaquin County, California**

Dear Ms. Dermer:

PG&E has reviewed EPA's comments provided in their August 27, 2015 letter to PG&E on the following PG&E documents for the PG&E Test Injection/Withdrawal Well 1:

- A. Response to Comments on April 2015 Monthly Report, dated July 8, 2015
- B. June 8, 2015 Updated Evaluation of Annular Pressure-Temperature Relationship, dated July 8, 2015
- C. Response to Comments on May 1-3, 2015 Fall-off Test, dated July 23, 2015
- D. Response to Comments on May 2015 Monthly Report, dated July 23, 2015

Note that A and B are part of the same PG&E document dated July 8, 2015 and C and D are part of the same PG&E document dated July 23, 2015; however, they are separated here to correspond to the numbering sequence in the subject EPA Letter dated August 27, 2015. Our responses to EPA's comments are provided below.

A. Comments on April 2015 Monthly Report, dated July 8, 2015

1. **EPA Comment:** Including the updated testing results evaluation in the quarterly reports is acceptable.

PG&E Response: Acknowledged.

2. **EPA Comment:** The thermal decay lithology log, temperature log, and bottomhole pressure (BHP) survey report were provided as requested. Please respond to the following comments:

- a. The Piacentine 1-27 well thermal decay lithology log may show an anomaly at a depth of 4,670 to 4,610 feet, potentially as high as 4,570 feet. *Please provide an explanation of the log response at this depth.*

PG&E Response: The thermal multi-gate lithology (TMDL) log response in the interval from 4,570 to 4,670 feet, corresponding exactly to the top and bottom of the Capay Shale, is a characteristic thermal decay neutron log response in a shale unit. The sigma intrinsic curve (SGIN) and sigma far formation curve (SGFF) provided by the near and the far neutron detectors provide the capture cross-section (in capture units or c.u.) of the formation lithology and pore fluid/gas, which is inversely proportional to the time for the thermal neutron population to decay. As can be seen in the table below, the capture cross-section of shale (35-55 c.u.) is much higher than for quartz (4.3 c.u.), the primary mineral in the sand units. The table also shows that brine has a higher capture cross-section than gas. Accordingly, the brine saturated Domengine sands will have a lower capture cross-section than the brine saturated Capay Shale due to the lower capture cross-section of quartz-dominated sand compared to shale, which is consistent with the significant deviation to the left of the SGIN and SGFF curves (to higher capture units) from the Domengine to the Capay Shale at 4,570 feet. From the Capay Shale to the top sand lobe of the MRF at 4,670 feet, the SGIN and the SGFF curves deviate back to the right (to lower capture units), consistent with the brine and gas filled upper MRF sand. The fact that SGIN and SGFF curves in the brine and gas filled upper MRF sand do not read lower capture units than the brine filled Domengine sands is probably due to the more shaly lithology of the upper MRF compared to the Domengine.

TABLE 3D.8—THEORETICAL MACROSCOPIC CAPTURE CROSS SECTIONS OF A FEW MATERIALS OF RESERVOIR INTEREST	
Mineral	Capture Cross Section (c.u.)
Quartz	4.3
Calcite	7.3
Dolomite	4.8
Glauconite	25
Chlorite	25
Shale	35–55
Fresh water	22
Gas	0–12
Oil	18–22
Brine (50 kppm NaCl)	35–40
Brine (200 kppm NaCl)	95–100

Source: http://petrowiki.org/File%3AVol5_Page_0277_Image_0001.png

The near counts (NCAP) and far counts (FCAP) traces (track 3) spread apart below approximately 4,611 feet due to a change in wellbore conditions. Above the packer set at 4,611 feet is tubing with KCL water between the casing and tubing and below the packer is gas-filled wellbore. The

effect of the change in wellbore conditions at 4,611 feet is even more evident on the SGBF (Sigma far borehole) trace in track 1.

- b. The temperature log indicates an increase in temperature at the MRF reservoir depth, which is indicative of the air bubble reaching the Piacentine 1-27 well. The horizontal temperature scale is broad, and may not be sensitive enough, at 60 to 179 degrees F (approx. 13 degrees per inch) to discern more subtle temperature gradient changes. The EPA Temperature Logging Requirements document specifies a scale of 1 to 2 degrees per inch. Also, the complete gamma ray log trace from total depth to the surface was not provided on the log. Nonetheless it appears that there are no anomalies above the MRF reservoir, which would indicate an absence of fluid movement out of the MRF reservoir and into or between USDWs. *Please provide the log with the complete gamma ray log trace as required by the permit.*

PG&E Response: In PG&E's letter to EPA titled *Revised Temperature Log for Piacentine 1-27 Observation Well* dated August 18, 2015, it was noted that the only gamma ray log trace available for the Piacentine 1-27 was from the thermal multi-gate decay lithology (TMDL) log, which covers only the bottom portion of the logged interval (from 4,169 to 4,682 feet). To the best of PG&E's knowledge, a log with a complete gamma ray trace for the Piacentine 1-27 well, which was drilled and completed in July 1986, does not exist.

- c. The two BHP survey reports consisted of Excel spreadsheets of the raw pressure and temperature data versus time, however the pressure gradient survey data used to convert the surface pressure to BHP is not included. *Please provide the pressure gradient survey for the Piacentine 1-27 well.*

PG&E Response: The BHP pressure gradient surveys conducted in the Piacentine 1-27 well on April 4, 2015 are enclosed with this response letter.

B. Comments on the June 8, 2015 Updated Evaluation of Annular Pressure-Temperature Relationship in the PG&E Test Injection/Withdrawal Well 1, dated July 8, 2015

1. **EPA Comment:** Response is acceptable. PG&E is correct that Part II.D.2.b.iii of the permit requires an internal mechanical integrity test (MIT) be conducted in the Piacentine 1-27 observation well at the conclusion of the CAES post-test monitoring period. *There are no revisions to this permit requirement.*

PG&E Response: Acknowledged.

C. Comments on the PG&E Responses to EPA Comments on May 1-3 Fall-off Test (FOT)

1. **EPA Comment:** In this version of the FOT report PG&E presents 2,080.2 psia as the initial reservoir pressure (P_i) at the top of the Mokelumne River Formation (MRF) reservoir for the I/W Test Well 1. A P_i of 2080.2 psia compares with the initially calculated value of 2,050 psia at the same depth (4,671 feet true vertical depth), presented in the May 1-3, 2015 Fall-off Test report dated June 2, 2015. In addition, that value, 2,050 psia, was used in the Area of Review evaluation in the UIC permit application, based on the estimated depth to the top of the MRF reservoir of approximately 4,670 feet at the proposed I/W Test Well 1 location as depicted in Figure F-13 in the permit application. The precise value for P_i is difficult to determine since the calculation of P_i was based on short duration surface shut-in pressures and uncertain well conditions at the time the pressure readings were recorded.

The originally presented P_i value of 2,050 psia was based on an initial reservoir pressure gradient of 0.439 psi/foot in the Moresco et al Unit A-1 discovery well, which was also the basis for the modeling and zone of endangering influence (ZEI) evaluations presented in the UIC permit application; and later in conjunction with the FOT ending on October 28, 2014. In addition, the P_i of 2,050 psia more closely represents the current pressure gradient of 0.437 psi/foot in the lowermost underground source of drinking water (USDW) in the overlying Domengine Formation. P_i in the MRF reservoir is important for comparison to reservoir pressure behavior, while the current pressure gradient in the lowermost USDW is the more critical parameter to be used to enforce, if necessary, the permit requirement to plug and abandon the I/W Test Well 1, and possibly perform a ZEI re-evaluation when the MRF reservoir pressure stabilizes during the post-test period. *Based on the information provided, EPA does not accept the proposed increase of the estimated initial reservoir pressure from 2,050 psia to 2080.2 psia. P_i remains at 2050 psig.*

PG&E Response: Throughout most of their comment, EPA states the 2,050 P_i value in units of psia (absolute pressure); but at the end of the comment states “ P_i remains at 2050 psig” (gauge pressure). As shown on Graph A-2b from Attachment A-2 (Mokelumne River Formation Pressure Buildup Model Results) of Attachment A (Area of Review) of the Final UIC Application (Revised April 18, 2014), the pressure value for the I/W well is given as **2,050 psig**. This pressure is based on a hydrostatic pressure gradient of 0.439 psig/ft at discovery in the Moresco A-1 well (see footnote 4 in Table A-3 in Attachment A of the Final UIC Application) and an estimated vertical depth to the top of the MRF reservoir of 4,670 feet. Assuming the same pressure gradient, the hydrostatic pressure is approximately the same (2,050.6 psig) at the depth of the top of the MRF injection zone (4,671 feet TVD). The equivalent absolute pressure is **2065.3 psia**.

Note that in PG&E’s response in their letter to EPA dated July 23, 2015, a gas gradient of 0.044 psi/ft was correctly used to depth correct the average P_i from the Moresco A-1 and Piacentine 1-27 wells of 2,083.7 psia at -4,743 feet subsea to 2080.2 psia at -4663 feet subsea (4,671 feet TVD). Even though PG&E believes that based on the information available to date that 2,080.2 psia is the more accurate initial reservoir pressure, PG&E accepts using a hydrostatic gradient of 0.439 psig/ft to

derive a target reservoir pressure, which at the top of the MRF injection zone (4,671 feet TVD) is **2065.3 psia**.

D. Comments on the Responses to EPA Comments on the May 2015 Report

1. **EPA Comment:** Response is considered acceptable.

PG&E Response: Acknowledged.

2. **EPA Comment:** Response is acceptable. PG&E provided copies of the thermal decay lithology log, temperature logs, and the BHP surveys that were run in the Piacentine 1-27 well, as requested. *In addition to copies of the logs and BHP survey data, EPA requests an interpretation of the thermal decay lithology log and a copy of the pressure gradient survey as noted in comment A. 2. a and c, above.*

PG&E Response: The thermal decay lithology log interpretation is provided in response to EPA comment A.2.a. The pressure gradient survey is provided in response to EPA comment A.2.c.

If you have any questions regarding these responses or require additional information, please feel free to contact me at (415) 973-6270.

Sincerely,

A handwritten signature in blue ink, appearing to read "Mike Medeiros".

Mike Medeiros
Manager, Renewable Energy Development

Cc: Mr. James Walker, EPA Consultant
Mr. Michael Woods, Division of Oil, Gas and Geothermal Resources
Ms. Anne L. Olson, Central Valley Regional Water Quality Control Board

Enclosures: Data CD Including:

Attachment 1 – Piacentine 1-27 well BHP gradient survey conducted on April 4, 2015